

Extended Range Electric Vehicle Driving and Charging Behavior Observed Early in The EV Project

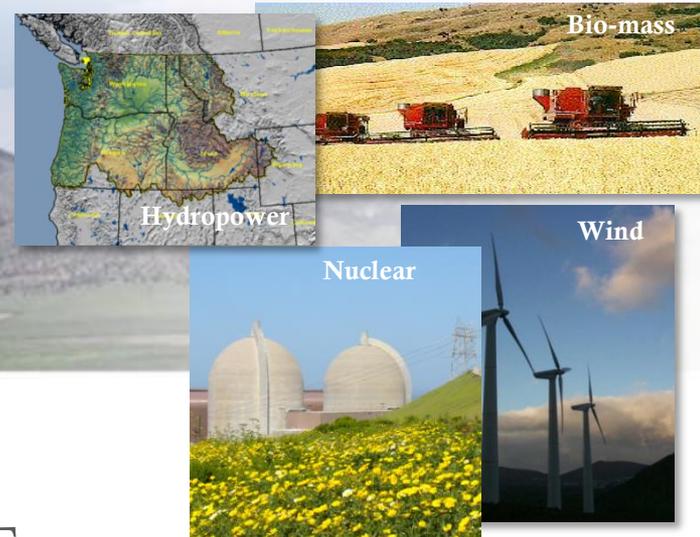
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Outline

- Overview of INL and The EV Project
- Purpose of the paper
- Results: Chevrolet Volt driving and charging behavior from October 2011 to October 2012



Idaho National Laboratory (INL)

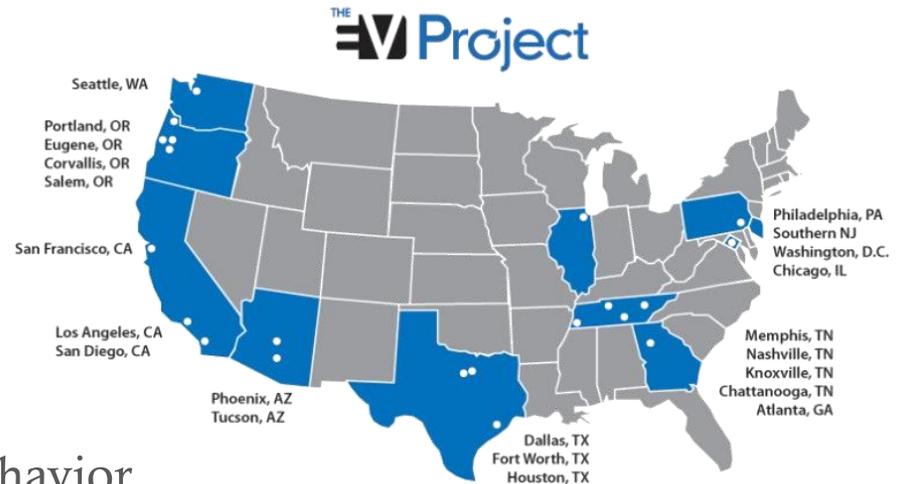
- Eastern Idaho based U.S. Department of Energy Federal laboratory
- 890 square mile site with 3,600 staff
- Support DOE's strategic goal:
 - Increase U.S. energy security and reduce the nation's dependence on foreign oil
- Multi-program DOE laboratory
 - Nuclear Energy
 - Fossil, Biomass, Wind, Geothermal and Hydropower Energy
 - Advanced Vehicles and Battery Development
 - Energy Critical Infrastructure Protection

The EV Project

The world's largest EV infrastructure deployment project

Objectives:

- Build mature EV charging infrastructure in 16 US regions
- Study
 - Infrastructure deployment process
 - Customer driving and charging behavior
 - Impact on electric grid
- Create a learning laboratory to understand the infrastructure deployment requirements for the first 1 million grid-connected electric drive vehicles



The EV Project

- Deploy >13,000 residential and public **Blink** brand EVSE units
- Enroll >8,000 privately owned **Nissan LEAF** battery electric vehicles and **Chevrolet Volt** extended range electric vehicles
- Deployment from Oct 2010 – Dec 2013
- INL data collection phase from Jan 2011 – Dec 2013



Project Partners

Sponsor

Project lead



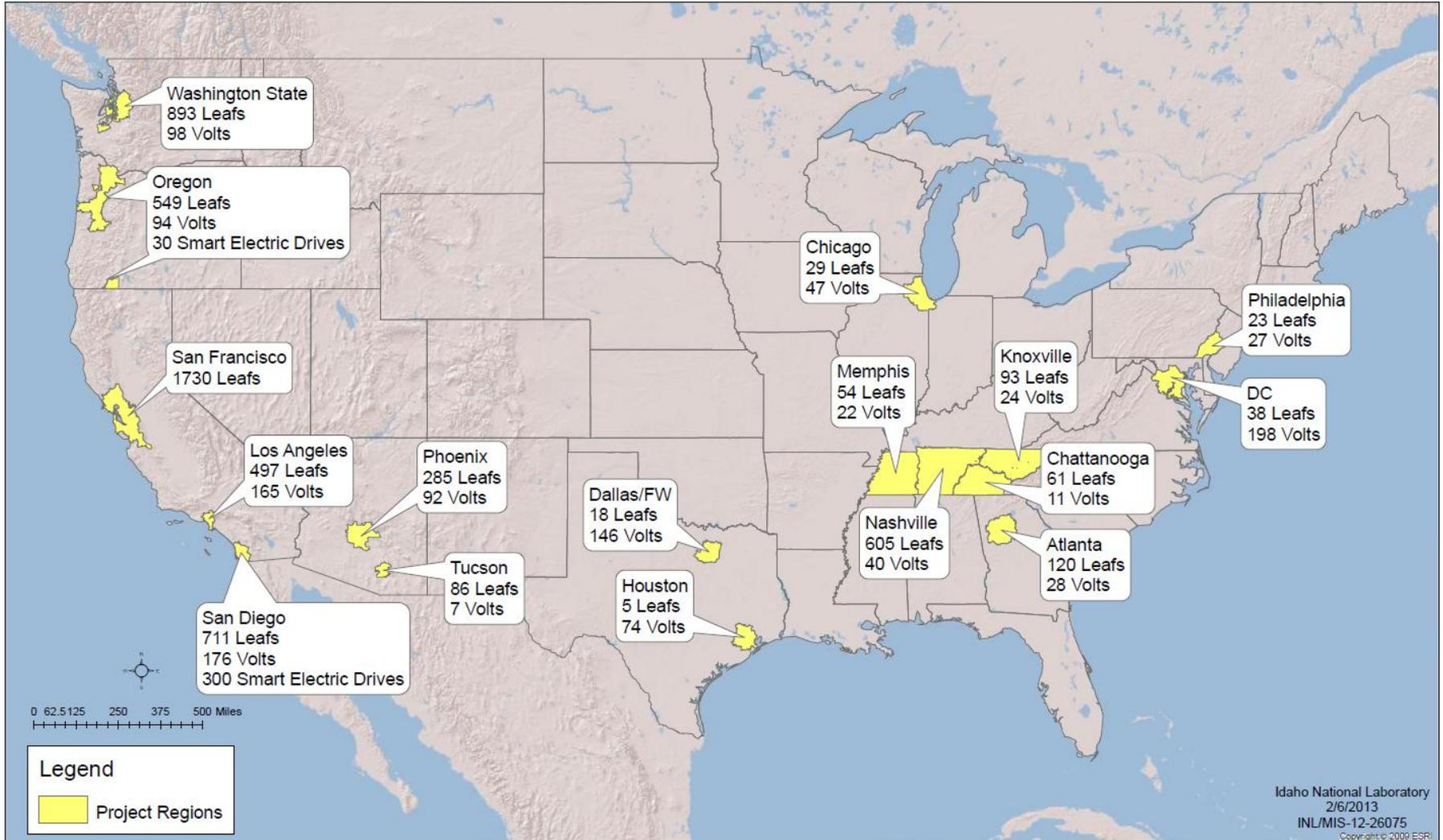
Primary Partners



The EV Project Locations

Nissan Leafs and Chevrolet Volts Reporting Data in The EV Project

Project to Date through December 2012



Purpose of paper

The purpose of this paper is to identify the potential for Chevrolet Volts enrolled in The EV Project to drive in EV-only mode, based on driver behavior and the available charging infrastructure

This paper also presents distributions of driving and charging behavior to expand on averages previously reported

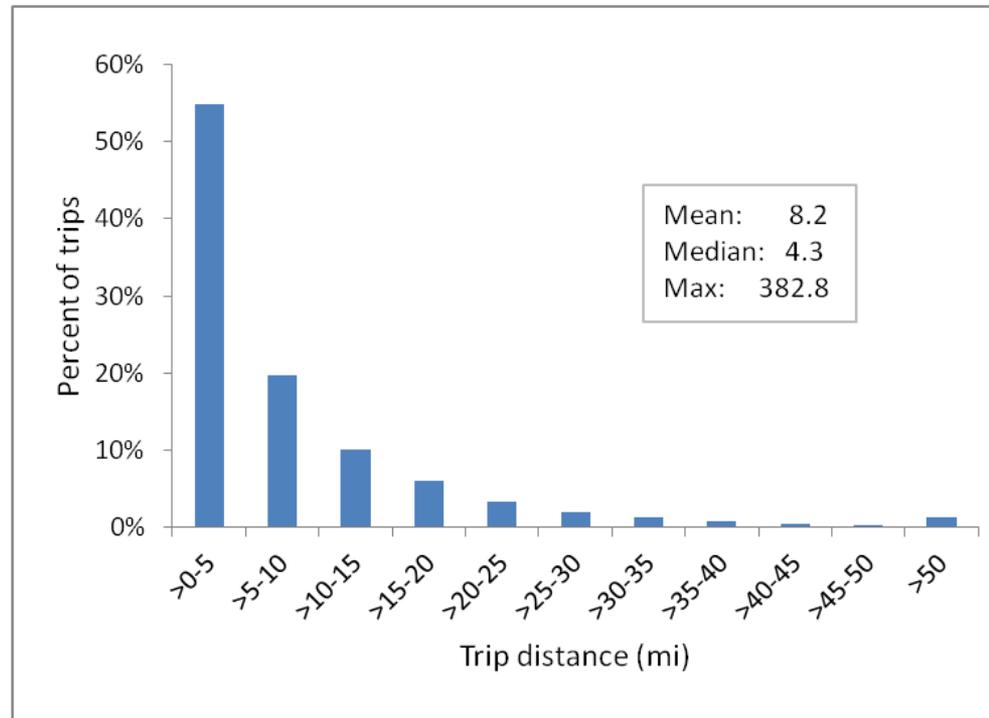
Results

- Metrics and distributions to quantify driving and charging behavior were calculated from in-use electronic data logged by:
 - 923 Chevrolet Volts
 - From October 2011 to October 2012
- Vehicles privately owned and operated
- Located in all project regions
- Logged
 - 4,757,672 miles
 - 579,828 trips
 - 170,311 charging events



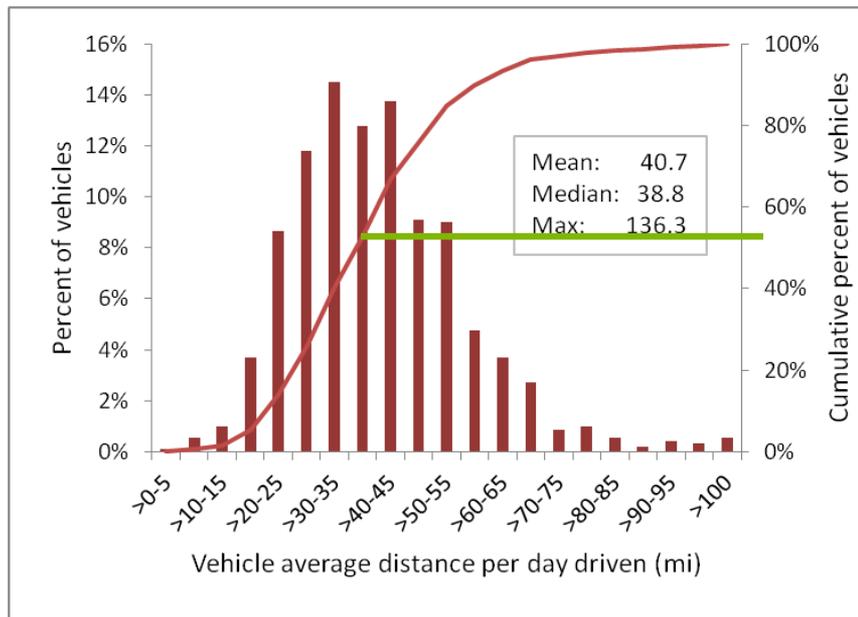
Observed Driving and Charging Behavior

- Distribution of Trip Distance



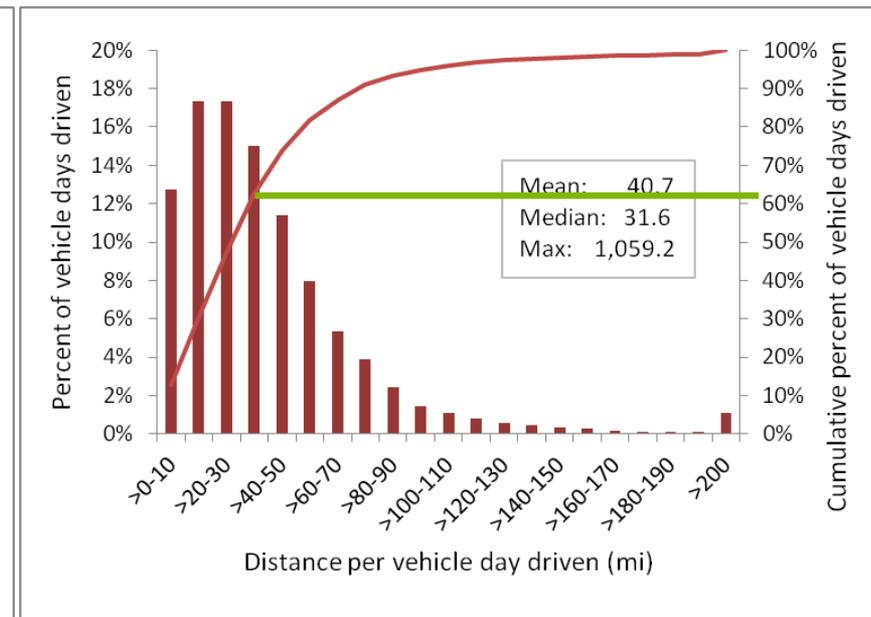
Daily Vehicle Miles Traveled

- Distribution of vehicle average distance per day



53% of vehicles averaged 40 mi per day or less

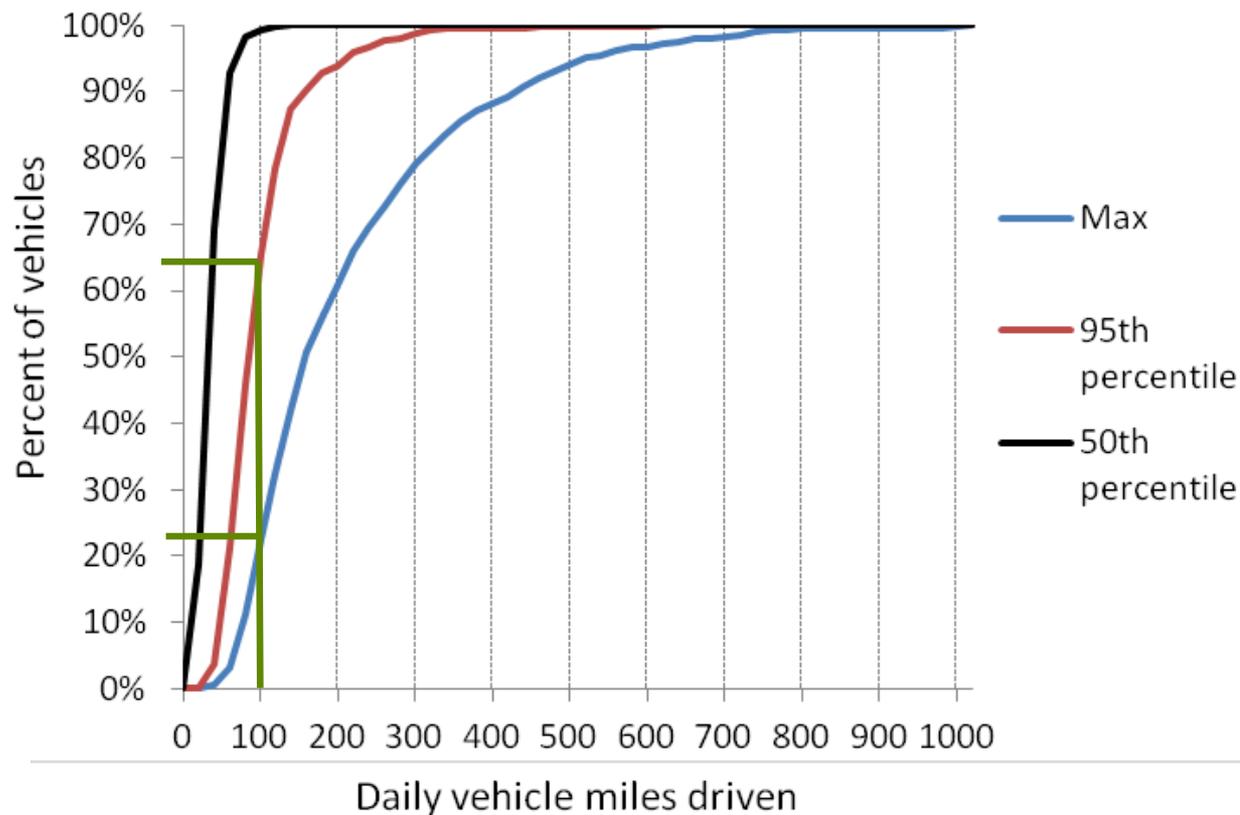
- Distribution of distance per vehicle day



62% of vehicle driving days had 40 mi or less

Miles per day

- Distributions of maximum, 95th percentile, and median distance per day driven

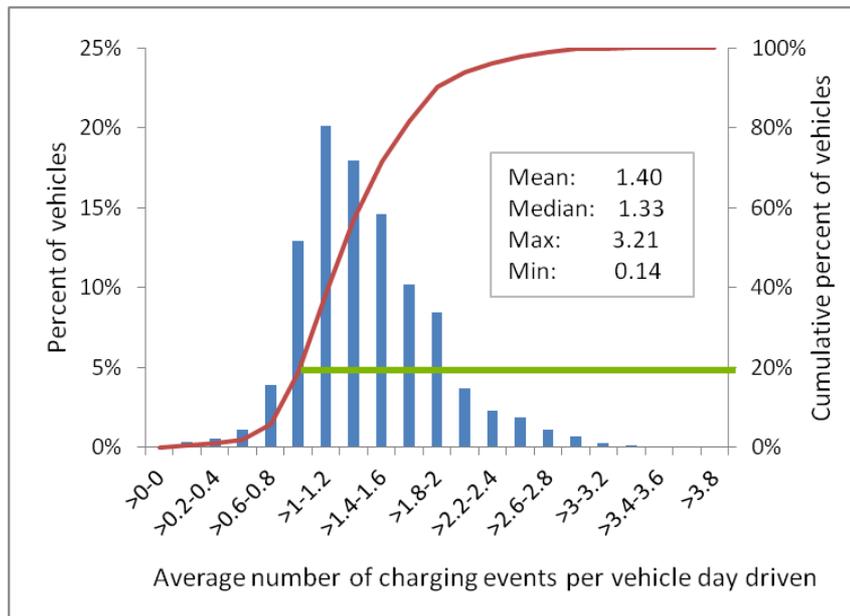


23% of vehicles never drove more than 100 mi in one day

35% of vehicles had a 95th percentile driving day over 100 mi, meaning they drove >100 mi on 5% or more of their driving days

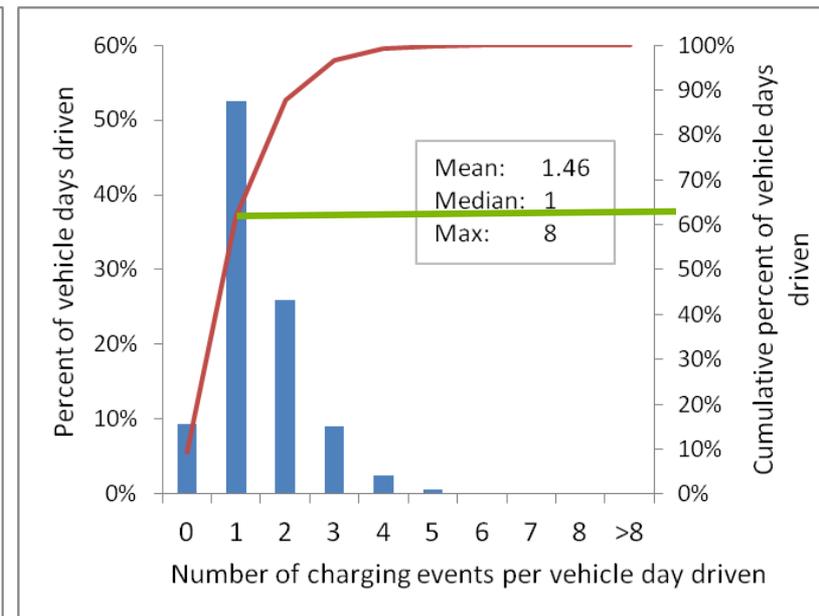
Charging events per day

- Distribution of vehicle average charging events per day



80% of vehicles averaged > 1.0 charging events per day driven

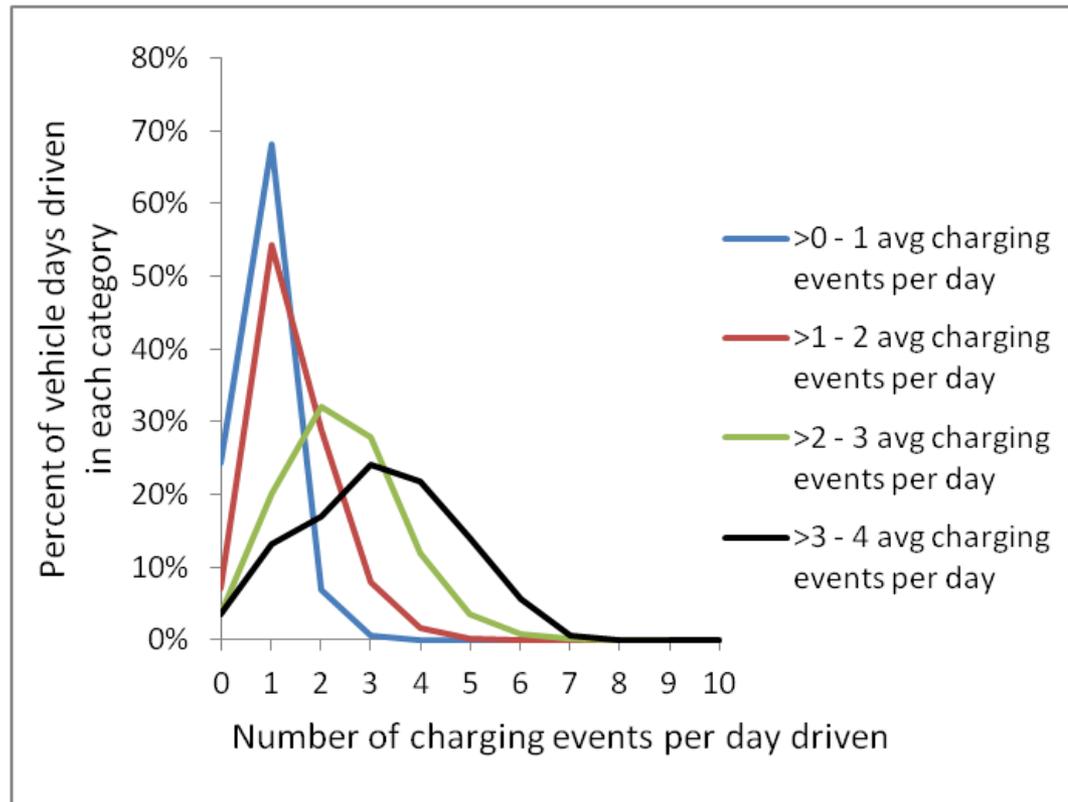
- Distribution of number of charging events per vehicle day



62% of vehicle driving days had 0 or 1 charging event

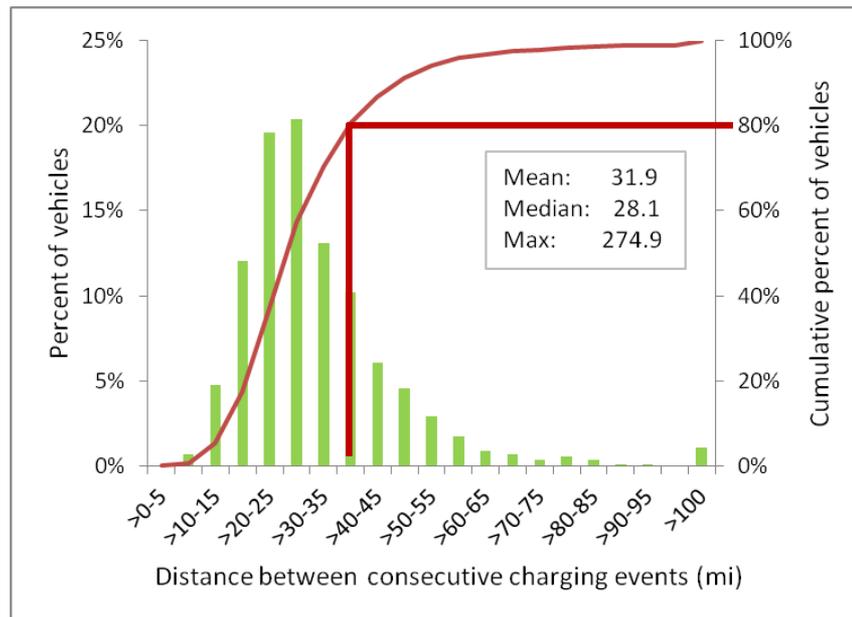
Charging events per day

- Distribution of charging events per vehicle day for vehicles with different average charging frequency



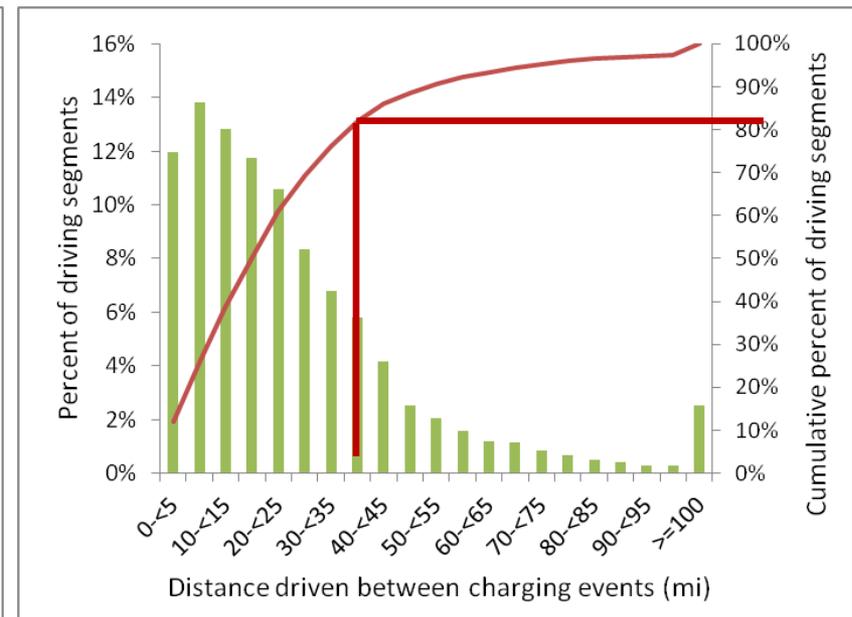
Miles driven per charge

- Distribution of vehicle average “driving segment” distance driven between charging events



81% of vehicles averaged 40 mi or less between consecutive charging events

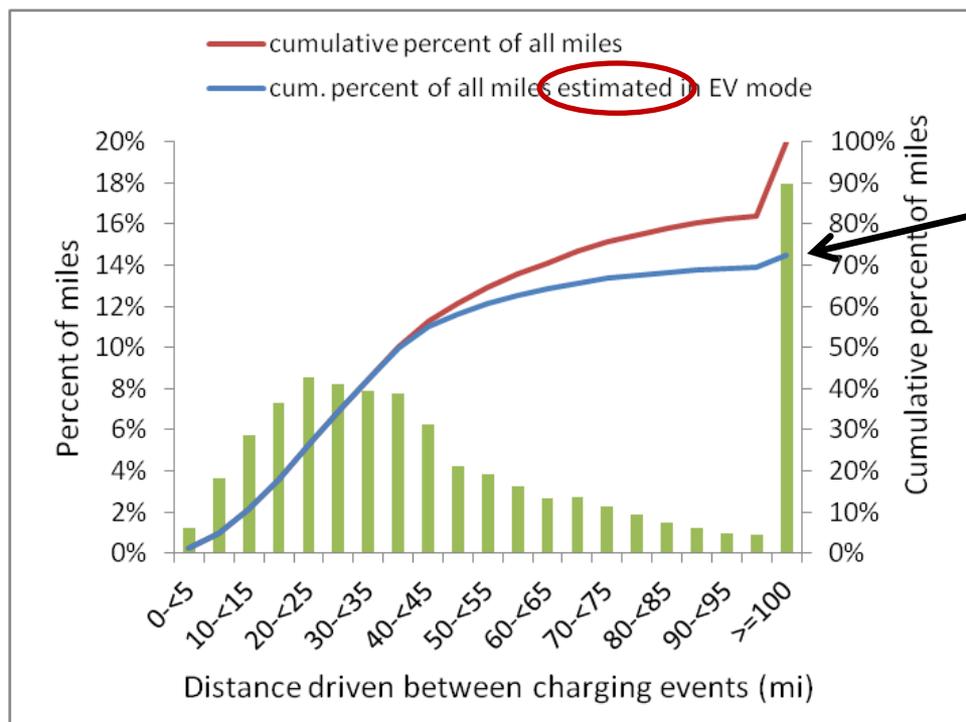
- Distribution of “driving segment” distance between charging events



82% of vehicle driving days had less than 40 mi between charging

Miles per Charge Yields Percent of EV Miles

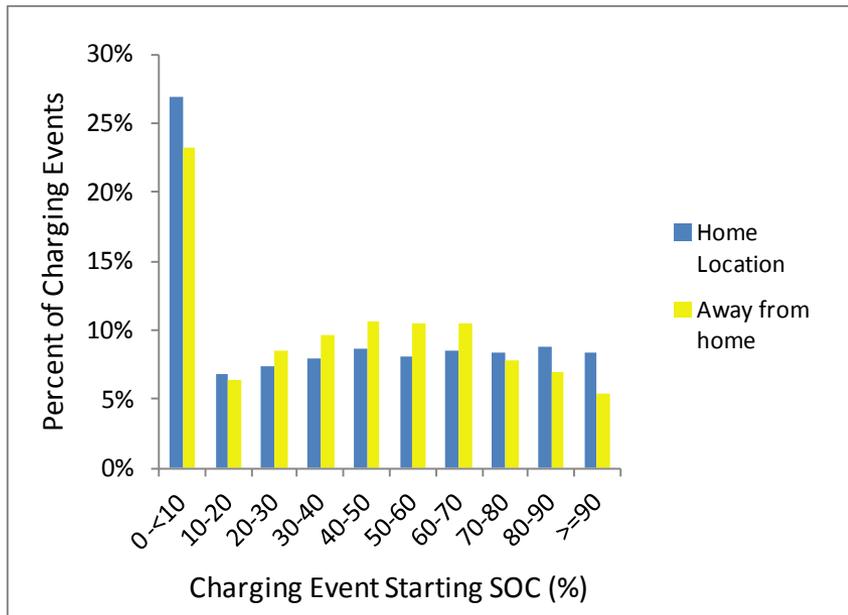
- Miles-weighted distribution of driving segment distance between charging events



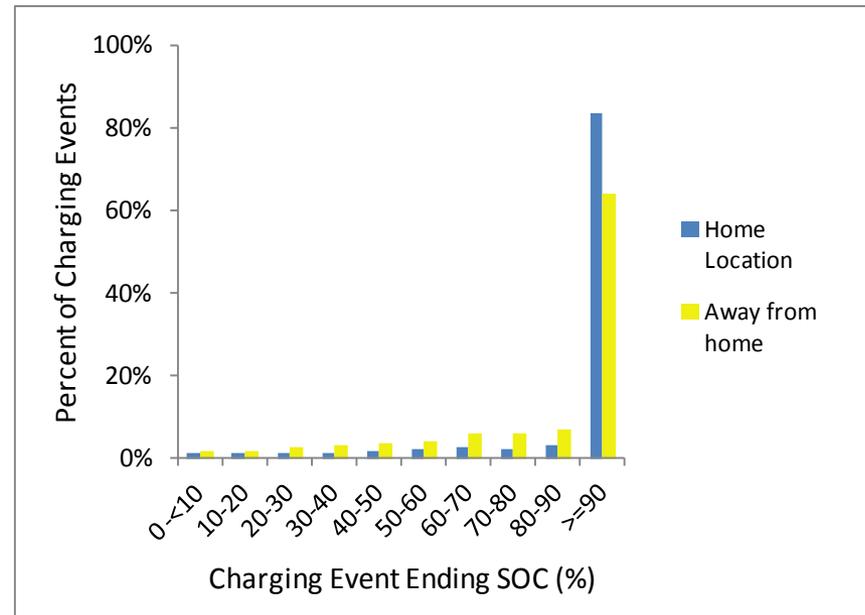
Potential for up to 73% of miles in EV mode

Charging Completeness

- Distribution of battery pack SOC at the start of charging by charging location



- Distribution of battery pack SOC at the end of charging by charging location



Conclusion

- Percentage of EV mode driving determined by total distance driven beyond vehicle's all-electric range
- 35 miles of each segment would be driven in EV mode if:
 - All charging events end with a full battery
 - Vehicle's EV mode range is exactly 35 miles
- Resulting in estimated EV mode operation for 73% of all miles driven in data set
- Of course EV mode operation varies based on
 - Charging duration, power level, battery state of charge at beginning of charge, driving style, conditions, etc.

Acknowledgements

This work is funded in part by the
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For more results from The EV Project:

www.theevproject.com

avt.inl.gov/evproject.shtml



blink

www.theevproject.com
avt.inl.gov/evproject.shtml

Influences on Behavior

- Early adopters, early market
- Limited public charging opportunities
- Drivers new to Chevrolet Volt, probably new to electric vehicles

Distribution of vehicle miles-in-service

